WE CLAIM:

1. A regenerable sorbent for removing trace amounts of oxygen from either a gas-stream or a closed system, the sorbent comprises:

a mixed-oxide material composed by weight of about 1% to about 99% Ce_2O_3, about 0% to about 99% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and

at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount of 0% to about 10 %, on a surface of said mixed oxide material.

2. The sorbent according to claim 1, wherein said cerium oxide content ranges from about 20% to about 95% by weight.

3. The sorbent according to claim 1, wherein said zirconium oxide content is 5-80% by weight.

4. The sorbent according to claim 3, said zirconium oxide content is about 40-50% by weight.

5. The sorbent according to claim 1, wherein said mixed-oxide material is of a single-phase metastable matrix.

6. The sorbent according to claim 1, wherein said R_xO_y is a transition metal or rare earth metal oxide.

7. The sorbent according to claim 5, wherein said R_xO_y is Y_2O_3, Sc_2O_3, Nd_2O_3, or Sm_2O_3.

8. The sorbent according to claim 1, wherein said transition metals and oxides thereof are of either Pd, Rh, Pt, Ir or a combination thereof in an amount of about 0.01 to 5% by weight.

9. The sorbent according to claim 1, wherein said mixed oxide material has a surface area ranging from about 0.1 m^2/g to about 150 m^2/g.

10. The sorbent according to claim 1, wherein said mixed oxide material has a crystal size ranging from about 1 nm to about 100 microns.

11. The sorbent according to claim 8, wherein said mixed oxide material has a crystal size ranging from about 4 nm to 90 microns.

12. The sorbent according to claim 1, wherein said sorbent can operate in a wide range of temperatures, from about – 40°C up to about 1200°C.

13. The sorbent according to claim 1, wherein said sorbent can operate in a temperature range from about either 0°C or ambient room temperature (~20°C) to about 1000°C.

14. The sorbent according to claim 1, wherein said material has additional capacity to take up any oxygen that may seep through hermetical seals into an enclosed environment or container.

15. The sorbent according to claim 1, wherein after complete reduction of said material, the oxygen sorption capacity is at least 2 times greater than conventional sorbents per volume.

16. The sorbent according to claim 1, wherein the oxygen capacity is about 10-15 ml per gram.

17. The sorbent according to claim 1, wherein said sorbent can operate in noxious environments, which would otherwise poison conventional catalysts.

18. A method of preparing an oxygen sorbent, the method comprising:

a) preparing a mixture of mixed-oxide compounds;

b) precipitating a mixed metal hydroxide with a concentrated base solution of mixed bases, from said mixed-oxide mixture;

c) collecting said hydroxide precipitate and washing with a liquid-phase solvent;

d) calcinating said hydroxide precipitate to a mixed-oxide material in flowing air.

19. The method according to claim 18, the method further comprising impregnating metal or metal oxides on and in said mixed-oxide material; and activating said hydroxide precipitate or mixed oxide material.

20. The method according to claim 18, wherein a single-phase mixed oxide matrix of ceria and zirconia is produced, having a ceria content of up to about 95 mole %.

21. The method according to claim 20, wherein said ceria content in said mixed-oxide material is about 50-80 mole %.

22. The method according to claim 20, wherein said single-phase material is of a metastable mixed-oxide matrix.

23. The method according to claim 19, wherein said metal or metal oxides are of transition or precious metals, including at least one of the following: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount of 0% to about 10 %.

24. The method according to claim 19, wherein said activating step is a reduction of said hydroxide precipitate or mixed-oxide material.

25. The method according to claim 18, wherein said mixture of mixed-oxide compounds includes an aqueous medium of at least a soluble cerium compound and at least a soluble zirconium compound.

26. The method according to claim 25, wherein said mixed-oxide compounds include soluble cerium (III) or cerium (IV) salts, or soluble zirconium salts.

27. The method according to claim 18, wherein said mixed-oxide mixture is incorporated into said base solution.

28. The method according to claim 18, wherein said base is ammonium hydroxide.

29. The method according to claim 18, wherein said base concentration ranges from about 1M/L to 16 M/L.

30. The method according to claim 29, wherein said base concentration ranges from about 4M/L to 8 M/L.

31. The method according to claim 18, wherein said liquid-phase solvent is a dehydrating agent.

32. The method according to claim 31, wherein said liquid-phase solvent is an alcohol.

33. The method according to claim 32, wherein said liquid-phase solvent is ethanol.

34. The method according to claim 18, wherein said hydroxide precipitate is washed for 2 to 6 cycles.

37. The method according to claim 19, wherein said activating step is by means of reduction at about 400°C for about 4 hours.

38. The method according to claim 37, wherein said activating step uses hydrogen, carbon monoxide, hydrocarbon vapor, or other reducing agents.

39. The method according to claim 18, wherein said calcination step occurs at a temperature between about 250°C to about 600°C.

40. The method according to claim 39, wherein said calcinating step occurs at a temperature between about 400°C to about 500°C.

41. The method according to claim 18, wherein said calcinating step occurs for about 1-10 hours.

42. The method according to claim 41, wherein said calcinating step occurs for about 4 hours.

43. The method according to claim 18, wherein said sorbent can operate in noxious environments, which would otherwise poison conventional catalysts.

44. A process for producing a single-phase mixed oxide material in a ceria-zirconia system, the process comprising:

a) preparing a mixture of cerium and zirconium compounds in solution;

b) precipitating a mixed metal hydroxide with a concentrated base solution of mixed bases, from said mixed-oxide mixture by adding said mixed-oxide mixture into said base solution;

c) collecting said hydroxide precipitate and washing with a liquid-phase solvent;

d) calcinating said hydroxide precipitate to a mixed oxide material in flowing air.

45. A regenerable sorbent for removing trace amounts of oxygen from either a gas-stream or a closed system, the sorbent is made according to a method comprising:

a) preparing a mixture of mixed-oxide compounds;

b) precipitating a mixed metal hydroxide with a concentrated base solution of mixed bases, from said mixed-oxide mixture by adding said mixed-oxide mixture into said base solution;

c) collecting said hydroxide precipitate and washing with a liquid-phase solvent;

d) calcinating said hydroxide precipitate to a mixed oxide material in flowing air.

46. A device comprising an enclosure, a component susceptible to degradation from oxygen, and a getter material comprising a mixed-oxide carrier composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 90% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof, on a surface of said mixed oxide carrier, and an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixtures thereof.

47. The device according to claim 46, wherein said getter material can absorb residue oxygen in hermetic packages to levels below 1 part per trillion (ppt), over a temperature range from about -40°C, through ambient room temperature, to about 500°C.

48. The device according to claim 46, wherein said mixed-oxide material is of a single-phase metastable matrix.

49. The device according to claim 46, wherein said R_xO_y is a transition metal or rare earth metal oxide, including any one of the following: Y_2O_3, Sc_2O_3, Nd_2O_3, or Sm_2O_3.

50. The device according to claim 46, wherein said transition metals and oxides thereof are of either Pd, Rh, Pt, Ir or a combination thereof in an amount of about 0.01 to 5% by weight.

51. The device according to claim 46, wherein said device is an opto-electonic telecommunication module.

52. The device according to claim 46, wherein said device is an organic or polymer device.

53. The device according to claim 46, wherein said device includes a modulator, wavelength multiplexer or demultiplexer, coupler, optical switch, organic or polymer light emitting diode (OLED).

54. The device according to claim 46, wherein said device is a polymeric thermo-optical switch.

55. The device according to claim 46, wherein said device is an electro-optic modulator based on a planar Mach-Zehnder waveguide design.

56. The device according to claim 46, wherein the device is a micro-optic component containing a polymeric gel or optical path adhesive that is photo-oxidizable.

57. The device according to claim 46, wherein said components includes optical adhesive, refractive index gels, splices between optical sub-components, fiber-waveguide or fiber-lens interface, low-loss material, or interferometer.

58. A hermetically sealed opto-electronic package comprising:

a sealed enclosure in which there is an atmosphere and a component that is adversely affected by the presence of gaseous oxygen or other impurities in said atmosphere; and

a getter material comprising a mixed-oxide material composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 80% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount, on a surface of said mixed oxide material, and an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixtures thereof.

59. The package according to claim 58, wherein said getter material can absorb residue oxygen in hermetic packages to levels below 1 part per trillion (ppt), over a temperature range from about -40°C, through ambient room temperature, to about 500°C.

60. A method of providing a virtually O_2-free atmosphere in an opto-electronic device package, the method comprises:

a) providing a photonic device;

b) providing a housing;

c) providing a getter material comprising a mixed-oxide material composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 80% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount, on a surface of said mixed oxide material;

d) enclosing said photonic device and said getter within said housing; and

e) removing oxygen and other contaminant vapors from said opto-electronic component.

61. The method according to claim 60, wherein said getter material further comprises an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixtures thereof.

62. The method according to claim 60, further comprising locating said getter material in a package assembly.

63. The method according to claim 60, wherein said getter material can absorb residue oxygen in hermetic packages to levels below 1 part per trillion (ppt), over a temperature range from about –40°C, through ambient room temperature, to about 500°C.

64. An opto-electronic system comprising:

a photonic device;

a housing; and

a getter material comprising a mixed-oxide material composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 80% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount, on a surface of said mixed oxide material.

65. The system according to claim 64, wherein said getter material further comprises an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixture thereof.

66. A photonic component getter comprising:

a regenerable sorbent, the sorbent comprises: a mixed-oxide material composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 80% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and

at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount, on a surface of said mixed oxide material; assemblying said getter material in a package assembly.

67. The getter according to claim 66, wherein said sorbent further comprises an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixtures thereof.

68. A method of making a photonic component getter material, the method comprising:

a) preparing a mixture of mixed-oxide compounds;

b) precipitating a mixed metal hydroxide with a concentrated base solution of mixed bases, from said mixed-oxide mixture;

c) collecting said hydroxide precipitate and washing with a liquid-phase solvent;

d) impregnating metal oxides on and in said mixed oxide powder;

e) calcinating said hydroxide precipitate to said mixed oxide in flowing air; and

f) activating said hydroxide precipitate;

g) shaping said hydroxide precipitate into a form;

h) assembling said getter material in a package assembly.

69. The method according to claim 68, wherein said getter material has a form that includes pellets, ribbons, beads, bricks, and bulk monoliths.

70. The method according to claim 68, wherein said liquid-phase solvent is a dehydrating agent.

71. The method according to claim 70, wherein said liquid-phase solvent is an alcohol.

72. The method according to claim 68, wherein said activating step is by means of reducing agents.

73. A method of packaging an opto-electronic device, the method comprising:

providing a regenerable sorbent, the sorbent comprises: a mixed-oxide material composed by weight of about 20% to about 95% Ce_2O_3, about 5% to about 80% ZrO_2, and 0% to about 25% R_xO_y, wherein R_xO_y is another metal oxide, and x and y are integers; and

at least one of the following transition metals: Fe, Co, Ni, Cu, Ru, Pd, Rh, Pt, Ir, Os, or their oxides or mixtures thereof in catalytic amount, on a surface of said mixed oxide material; assemblying said sorbent in a package assembly.

74. The method according to claim 73, wherein said sorbent further comprises an inorganic binder and components chosen from the group including MCM-22, -24, -30, -41, zeolite type A, X, Y, L, ZSM-5, mordenite, cloverite, porous silica, porous borosilicate, activated carbon, activated alumina, porous alumina, and mixtures thereof.

75. The method according to claim 73, wherein the method further comprises forming the sorbent into a shape.

76. The method according to claim 75, wherein said shape includes beads, pellets, granules, ribbons, slab, brick, ring, sheet or other bulk forms.

77. The method according to claim 73, further includes placing said getter into a porous getter housing.